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Research Article

Body Composition of Thin-Tailed Lambs Under Different Feeding Levels

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Abstract | A study was carried out to investigate the effect of feeding level on body composition of thin-tailed lambs. Twenty one thin-tailed lambs (aged 3 months) were allocated into a completely randomised design with 3 treatments of feeding level, namely T1= 4% body weight (BW), T2 = 5.5% BW and T3 = ad libitum. The diet was given in pellet form, containing 61.79% total digestible nutrients (TDN) and 13.74% crude protein (CP). The lambs were raised from an initial body weight of 11 kg until their body weight reached 25 kg. The parameters measured were body weight gain (BWG), feed conversion ratio (FCR), and body composition . The results showed that the lambs of T3 had the highest ($P<0.01$) BWG (235.17 g/d) as compared to that of T2 (138.17 g/d) and T1 (81.08 g/d). Feeding level T3 resulted in the lowest ($P<0.01$) FCR (6.37), while that of T1 and T2 did not have significant difference in FCR (averaged 8.21). There was no significant effect ($P>0.05$) of feeding levels on body composition. However, the body composition changed as the body weight increased ($P<0.01$). The higher the body weight, the lower the body water content and the higher the body fat content, while body protein content was relatively constant from 11 to 25 kg body weight. The average of body water, body protein and body fat content of the lambs at 11 kg were 58.63%, 10.38% and 20.59, respectively. Meanwhile, the average body water, body protein and body fat content of the lambs at 25 kg were 58.04%, 13.26% and 21.42%, respectively. It was concluded that the feeding level did not affect the body composition of the lambs at the same body weight. However, the body composition of the lambs varied with the body weight.

Keywords | Body composition, Feed conversion rasio, Feeding level, Lamb, Live weight gai

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INTRODUCTION

Feed is the biggest expenditure, ranging from 60 to 80% of the total cost of animal production (Verbeke *et al*., 2015; Zhang *et al*., 2017). Therefore, the amount of feed required in the fattening programme is the most important component to be considered when calculating the profitability of increasing animal production (Aluns and Luthfi, 2018; Luthfi *et al*., 2014). In the fattening programme, high growth rate is highly expected in order to reduce the length of rearing period, then the total amount of feed required to achieve the target body weight is lower.

Links Researchers

High growth rate can be promoted by increasing feed and nutrient intake (Luthfi *et al*., 2014; Prima *et al*., 2016; Luthfi *et al*., 2018). Furthermore, a high growth rate accelerates the body maturation and has a significant effect on changes of body composition (Danso *et al*., 2018). Changes in body composition include changes in muscle and fat deposition (Ponnampalan *et al*., 2016; Rahmawati and Rianto, 2018). Several studies found that improving dietary nutrient composition increased growth rate and altered body composition. A study by Prima *et al*. (2019) found that increasing dietary protein content from 14% to 18% resulted in increased body weight gain, and the total body fat content also increased from 8.8% to 10%. A study by Skapetas *et al*. (2006) also found that when the body weight of lambs increased from 12 kg to 20 kg, there was an increase in body fat content from 20.8% to 23.6% Those studies were conducted based on different nutrients with the same rearing period, so that resulted in different slaughter body weight. This caused unclear information about the cause of differences in body composition of lamb, whether the alterations in body composition was really due to different feed quality or different slaughter weights.

Table 1: Feed stuff and nutrient contents of the diet.

Ingredients	**%**
Sugarcane	20
Rice bran	15
Cassava flour	36
Pollard	11
Soybean meal	10
Molasses	6
Minerals	2
Nutrients	%
Dry matter	90.06
Organic matter	79.13
Crude protein	13.74
Extract ether	2.27
Crude fibre	18.37
Ash	20.87
Neutral detergent fibre	54.88
Acid detergent fibre	39.99
Gross energy, cal/kg	3,476.73

There was still a very limited information about the effect of growth rate on body composition of lambs at the same body weight. Based on the explanation above, it was considered to be important to have information about the body composition of the lambs with different growth rate at the body weight. This study was to examine the body composition of lambs at the same body weight with different growth rates as a result of being given different feeding levels with the same nutrients content.

MATERIALS AND METHODS

The animals used in this study were 21 lambs (aged 3 mo; weighed 11.16 kg; cv = 1.17%). They were randomized and divided into 3 treatment of feeding levels and each treatment consisted of 7 replications. The treatments were 4% BW (T1), 5.5% BW (T2) and ad libitum (T3). The treatments were chosen to represent low growth rate (T1), medium growth rate (T2) and maximum growth rate (T3). The ingredients and nutrient content of the diet is presented in Table 1.

For the lambs of T1 and T2, the diet was offered twice a day, i.e. at 07.00 and 17.00 hrs; while for the lambs of T3, the diet was available at all time. The refusal was weighed in the next morning. The lambs were weighed every week to monitor their body weight (BW). The data of BW were used as a reference to determine the amount of diet that should be given according to the treatment. The lambs were reared until their BW reached 25 kg.

The parameters observed in this study were dry matter intake (DMI), dry matter digestibility (DMD), body weight gain (BWG), length of rearing time, and body composition including water, protein and fat content of the body. Dry matter intake was measured by the weight of the dietary DM offered minus the dietary DM refused. Dry matter digestibility was obtained from the difference between DMI and DM excretion as faeces The daily BWG was obtained by subtracting the final BW from the initial BW divided by the length of rearing.

Body composition was measured using the urea space method and carried out 3 times, namely at weights of 11 kg, 18 kg and 25 kg. The day prior to the measurement, the lambs were weighed to calculate the metabolic body weight ($BW^{0.75}$). The dose of urea to be injected was 0.65 ml/kg $BW^{0.75}$ as recommended by Astuti and Sastradipraja (1999). The urea was injected using a catheter and then pushed using 10 ml of NaCl to ensure all the urea entered the blood. The amount of urea that entered was calculated by weighing the syringe before and after use. Blood was taken at the 0th minute and 12th minute from the jugular vein. Then the blood sample was centrifuged at 3000 rpm for 10 minutes to obtain blood plasma so that the blood urea concentration could be analyzed. Empty body weight was defined as body weight minus viscera. The formula for determining body water followed Rule *et al*. (1986), while for protein and fat followed Panaretto and Till (1963).

Data Analysis

All data were analyzed using analysis of variance with a significance level of 5% and 1% to test for an effect on the treatments applied, if there were differences, proceed with Duncan's multiple range test.

RESULTS AND DISCUSSION

Dry Matter Digestibility and Body Weight Gain

The DMI, DMD and productivity of the lambs are shown in Table 2. There were highly significant differences (P<0.01) in DMI and BWG among the treatments, while DMD was not significantly different (P>0.05) among the treatments. The difference in DMI occurred due to the difference in the amount of diet offered to the lambs. The difference in DMI resulted in the difference in the amount of nutrients intake and deposited in the body. Daily BWG in lambs that received diet T3 in this study was greater than the finding by Prima *et al*. (2019). The study by Prima *et al*. (2019) showed that BWG of thin-tailed sheep that fed a diet containing 16% CP and 61% TDN was 151 g/day. This difference might be due to the differences in DMI and DMD. The DMI and DMD in this study were higher than the findings of (Prima *et al*, 2019). The higher the feed intake and digestibility, the higher the feed utilized to increase body weight, then feed efficiency will also increase.

In this study, the DMD was not significantly different (P>0.05) among the treatments (averaged 59.71%). This indicated that differences in feeding level did not affect DMD. This result was not parallel with the finding of Rianto *et al*. (2005) that when the difference of DMI was 25% or more, the digestiblity was altered. This study also was not in line with the NRC (1996) that the higher the DMI, the higher the passage rate of feed in the digestive tract, thereby reducing the DMD. The different result with previous study might be attributted to the fact that neutral detergent fiber (NDF) content of the diet was relatively high (54.88%). This implied that increasing the feeding levels from 4% to 7.9% (ad libitum) with high NDF content did not increased the passage rate of the digesta. Therefore, feed from a high feeding level (T3) allowed higher absorption and utilization of nutrients. It was similar to the finding of Shilesi *et al*. (2021) who found that high NDF (55.05%) promoting slow rate passage in the rumen, longer digesta retention time and higher digestibility.

The BWG of the lambs T3 was significantly the highest (P<0.01), followed by lambs T2, and lambs T1 was the lowest. These caused the lambs T3 to have the shortest rearing time and the lowest feed conversion ratio (FCR) (P<0.01), in comparison to those of lambs T2 and T1 (Table 2). This was due to the high feeding level increased the BWG, so that the target BW was achieved in a shorter time. The higher the DMI, the higher the nutrients that can be utilized for growth, so that it reduce the rearing time and FCR. Oksbjerg and Therkildsen (2017) stated the higher the muscle growth rate, the higher the daily gain and meat content in the carcass and the lower the FCR. Luthfi *et al*. (2014) also found that the higher feed intake (twice of maintenance) induced the productivity of kids and goat. It was because nutrients were used mainly for maintenance, then the excess was used for production. The more nutrients were used for production, it indicated that the feed given was very efficient. Mc Donald *et al*. (2010) claimed that an adequate dry matter intake and proper animal nutrient requirements are essential for diet formulation to prevent under- or over-nutrition and promote efficient nutrient utilization. As a result, a high feeding levels inducing higher growth rate and feeding efficiency had been identified in this study.

Table 2: Dry Matter intake, Dry Matter Digestibility, Body Weight Gain, Rearing Time and Feed Conversion Ration of Lambs under Different Feeding Levels.

Parameter	T1	T2	T3	p value
Dry matter intake (g/ day)	717^{A}	1009^{B}	1495^{C}	< 0.00
Dry matter digestibility (%)	60.70	59.04	59.41	0.56
Body weight gain (g/day)	81.08^{A}	138.17^{B}	235.17^{C}	< 0.00
Rearing time				
11 kg to 18 kg (day)	70.00^{C}	45.50^{B}	28.00^{A}	< 0.00
18 kg to 25 kg (day)	122.50^{A}	66.00^{B}	35.00^{C}	< 0.00
Feed conversion ratio	8.86^{B}	7.52^{B}	6.37^{A}	< 0,00

Body Composition

The results of body composition using the urea space method are presented in Table 3. The body composition of lambs was similar among treatments at same BW, namely at 11, 18 and 25 kg.

Feeding level had no significant effect on the body composition of lambs from the beginning to the end of rearing time (P>0.05). The body water, protein and fat content at a weight of 11 kg were 58.63%, 10.38% and 20.59, respectively. The water, protein and body fat content at 18 kg BW were 58.32%, 12.42% and 20.96%, respectively. The average of body water, protein and fat content at 25 kg BW were 58.04%, 13.26% and 21.42%, respectively. It is noticeable that the high growth rate by giving animal high feeding level with the same nutrient content did not change water, protein and fat body of lambs in the same body weight. The body composition in the same body weight was very similar. This finding was similar to the claim of Lawrie and Ledward (2022) that the animals of the same body weight had similar body composition. Honig *et al*. (2022) claimed that the body development of animals is usually understood as an increase in mass and expressed as body weight. In this study, the lambs having different growth rates as affected by different feed intake had similar body composition when they were measured at the same body weight.

The water, protein and fat body of lambs in this study was similar to the findings of Salido *et al*. (2016) and Rahmawati and Rianto (2018). Previous study by Salido *et al* (2016)

Table 3: Body composition of lambs under different feeding levels.

Body weight 11 kg	4%	5.5%	Ad libitum	P value
water (kg)	5,84	5,85	6,06	0,77
water (%)	58,65	58,63	58,62	0,23
protein (kg)	1,08	1,08	1,14	0,77
protein (%)	10,80	10,73	10,96	0,73
fat (kg)	2,05	2,05	2,13	0,75
fat (%)	20,62	20,54	20,62	0,23
Body weight 18 kg				
water (kg)	9,23	8,88	8,95	0,59
water (%)	58,35	58,27	58,34	0,80
protein (kg)	1,98	1,88	1,90	0,59
protein (%)	12,48	12,40	12,38	0,50
fat (kg)	3,32	3,15	3,22	0,87
fat (%)	20,91	20,98	21,00	0,79
Body weight 25 kg				
water (kg)	12,95	13,14	12,60	0,46
water (%)	58,04	58,05	58,03	0,24
protein (kg)	2,96	2,87	3,01	0,41
protein (%)	13,27	13,30	13,21	0,41
fat (kg)	4,77	4,84	4,62	0,45
fat (%)	21,39	21,38	21,49	0,77
Body composition changes from 11 kg to 18 kg				
water (kg)	3,39	3,02	2,89	0,20
water (%)	0,28	0,00	0,29	0,47
protein (kg)	0,90	0,80	0,77	0,20
protein (%)	1,68	1,66	1,42	0,47
fat (kg)	2,24	2,06	2,09	0,18
fat (%)	0,40	0,44	0,38	0,18
Body composition changes from BB 18 kg to BB 25 kg				
water (kg)	3,72	4,26	3,65	0,16
water (%)	0,31	0,36	0,31	0,45
protein (kg)	0,99	1,13	0,97	0,16
protein (%)	0,79	0,91	0,83	0,43
fat (kg)	1,45	1,69	1,40	0,09
fat (%)	0,53	0,40	0,35	0,58
Body composition changes from BB 11 kg to BB 25 kg				
water (kg)	7,10	7,28	6,54	0,22
water (%)	0,58	0,63	0,60	0,67
protein (kg)	1,88	1,93	1,73	0,22
protein (%)	2,48	2,57	2,24	0,50
fat (kg)	2,72	2,79	2,49	0,19
fat (%)	0,77	0,84	0,87	0,50

and Rahmawati and Rianto (2018) found that the body compositions of Thin Tailed lambs in Indonesia contained 58.53 - 58.71% body water, 11.01 - 11.99% body protein and 20.71 - 21.25% body fat. Moloney and McGee (2017) stated that the body composition in various tissue that form the animal's body is influenced by several factors such as genetics, age, body weight, and nutrients in the diet.

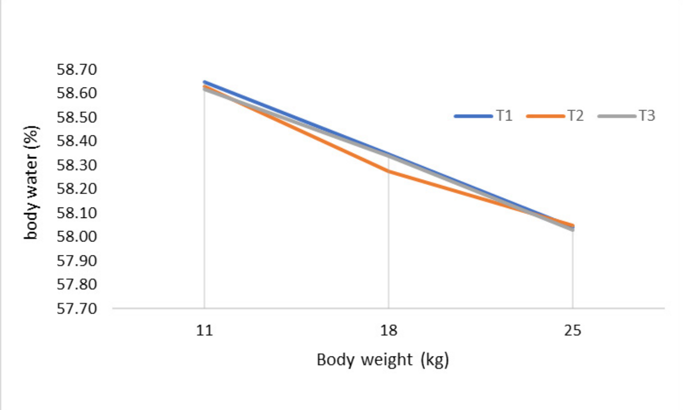

Figure 1: Body water change in lambs.

Although there was no different body composition at the same weight, this study showed that the body composition of water, protein and body fat changed as body weight increased from 11 to 25 kg (Figure 1). During the growth, body water tended to decrease (from 58.63% to 58.04%), the decreased was 0.33% in average in all treatments. This study showed that the higher body weight, the lower the water content in the body. In contrast, the body fat of lambs increased with the body weight (from 20.58% to 21.44%; Figure 2). It implied that the heavier the body weight, the greater the body fat of lambs. Changes in body composition in growing lambs were caused by massive development of body tissue, thus changing the chemical composition of body tissues. Shift in distribution of body water and body fat was consistent with the previous study by Honig *et al.* (2022) and McCurdy *et al.* (2010). Honig *et al.* (2022) found that the composition of body water in the bulls decreased by 13.1% during growth, while fat body increased by 15.1% from 200 to 600 kg BW. Judge *et al.* (2012) suggested that the reduction in body water was caused by an increase in body fat which was formed by the growth of fat in adipose tissue. Rahmawati and Rianto (2018) claimed that the increase in body fat was caused by increasing body weight and age. On the other hand, the increase of body fat caused body water to decrease. Owens *et al.* (1993) defined growth as an increase in the weight of body tissues due to increased cell proliferation and enlargement of cell size.

In contrast to the distribution of body water and fat, body protein proportion tended to be stable or there was no change from BW 11 to BW 25 kg (Figure 3).

The relatively constant proportion of body protein from 11 to 25 kg BW indicated that the proportion of muscle protein in the body did not alter with the increase of body weight. This was in accordance with the opinion López-Bote (2017) that the growth of body protein of animals at various body weight was relatively constant and no significantly changes. This present data was in line with the findings of Kirchgessner *et al.* (1993) reported there was no changes in body protein of bulls weighing 200 - 650 kg, namely containing around 20.2 - 20.0%.

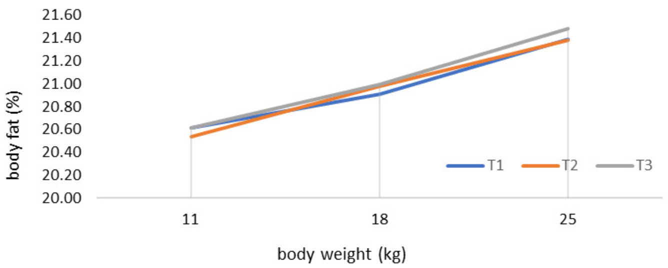

Figure 2: Body fat change in lambs.

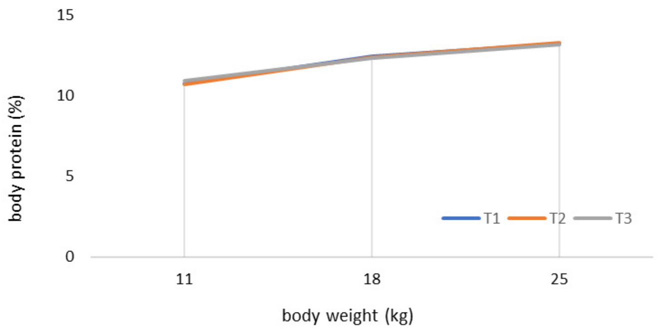

Figure 3: Body protein change in lambs.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results, it can be concluded that increasing feeding level up to 7.9% BW resulted in higher BWG, lower FCR and shorter rearing time. High feeding level with the same nutrient content did not affect body composition of lambs at the same body weight. However, body water and body fat of lambs changed as body weight increased up to 25 kg, while body protein tended to be stable. It is recommended for raising lambs under intensive feeding level (7.9% BW) to achieve final BW rapidly without altering body composition.

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NOVELTY STATEMENT

The novelty of our study entitled Body Composition of Thin-Tailed Lambs Under Different Feeding Levels can be summarized as: enhancing body compositions by increasing growth rate through different feed intake with the same nutrients at a certain body weight in young Thin-Tailed lambs.

AUTHOR'S CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Edy Rianto. Nadlirotun Luthfi; data collection: Nadlirotun Luthfi; analysis and interpretation of results: Retno Adiwinarti, Agung Purnomoadi; draft manuscript preparation: Edy Rianto, Nadlirotun Luthfi. All authors reviewed the results and approved the final version of the manuscript.

Appendix

The formula to calculate body composition can be written as follows:

• Urea Space = [(V x K)/ (Δ BUN x 10 x EBW)] where: V = volume of urea that has been injected (ml); K = urea concentration (mg/dl); Δ BUN = change in blood urea (0 and 12 minutes) (mg/100ml); US = urea space; BB = body weight (kg); EBW = met abolic body weight.
• Body water (%) = 59.1 + 0.22 x US (%) – 0.04 BW
• Body water (kg) = {body water (%) x EBW (kg)/100%}
• Body protein (kg) = 0.265 x body water (kg) – 0.47
• Body protein (%) = 100 x (body protein (kg) / EBW
• Body fat (%) = 98.0 – 1.32 x body water (%)
• Body fat (kg) = {body fat (%) x EBW (kg)}/100%

Conflict of Interest

The authors have declared no conflict of interest.

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